

Tuning Session Summary

ICFA Workshop on ML for Particle Accelerators

Feb 27 – Mar 2, SLAC

Overview of Talks

- FEL taper tuning – Juhao Wu
- Introduction to Bayesian Optimization – Johannes Kirschner
- Gaussian Process Optimization at SLAC – Joe Duris
- Tuning at XFEL + Online Modeling with Ocelot – Sergey Tomin
- Tuning at FERMI@Elettra + Stochastic Optimization – Giulio Gaio
- General Experience with Online Optimization (ES / RCDS) – Alexander Scheinker / Xiaobiao Huang
- Sloppy / Genetic Algorithms for Low-Emittance Tuning at CESR – Ivan Bazarov

Summary of Discussion

- ML-based tuning methods
 - RL for taper tuning: 2x increase in pulse energy; new zig-zag taper (new physics?)
 - Bayesian optimization / GPs → sample efficient way to trade off exploration/exploitation
 - How effective for different amounts of drift (varies from machine to machine)
- Already have very effective local optimizers that don't rely on any ML or knowledge of specific machine behavior
 - RCDS and ES – many examples in simulation + experimental results for wide range of applications (in-hardware beam loading compensation, tuning at LANSCE, various optimizations at SPEAR3 and other rings, taper optimization for LCLS)
 - Easily transferrable to different problems
 - Perhaps not yet as widely used in the accelerator community as they should be?
- Finding the most impactful knobs for tuning prior to optimization looks promising (esp. for then sending to methods that don't scale as well?)
- Important to develop good metrics for optimization (e.g. FEL quality factor at FERMI)

Summary of Discussion

- Do fall into local minima in machine tuning (manually + with automated tuning) – example from LCLS needing to re-tune from scratch
 - How to ensure you're in a suitable part of the parameter space at the start of local optimization?
 - How to realize when you're in a local minimum?
- Interplay between a priori system models, ML system models, non-ML local optimization algorithms, and ML-based optimization algorithms
 - When is it worth it to invest the development effort use ML for tuning?
 - How often switching between different configurations, how much drift in machine, how complex is the specific machine physics